Revisiting the origins of root-induced pH changes in the rhizosphere

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Several decades of research were dedicated to unravel the mechanisms involved in root-induced pH changes in the rhizosphere and finally to determine the major drivers. The most considered driver is unequivocally the plant nutritional status. The imbalance between cation and anion uptake, notably between ammonium and nitrate, leads to the net excretion of protons or hydroxyls by roots and consequently to the respective acidification or alkalization of the rhizosphere. Also, specific nutritional constraints related to the low availability in soil of mineral elements such as phosphorus (P) and iron (Fe) are usually considered to compel plants to acidify their rhizosphere. However, the importance of plant nutritional status in regulating pH changes in the rhizosphere was recently challenged by the comparison of results we obtained in rhizobox experiments performed with three plant species belonging to different families (i.e. a solanaceae, a brassicaceae, and a poaceae) and having a similar nutritional status (nitrate-fed plants without P or Fe starvation). pH patterns in the rhizosphere differed substantially between the three species and as a function of the initial bulk-soil pH. We therefore deepened these preliminary investigations by cropping under similar growing conditions three species belonging to the same three families already tested on 55 soil samples exhibiting an initial bulk-soil pH varying between 5 and 8. In agreement with the preliminary investigations, the lower the initial pH of a given bulk-soil, the higher the root-induced alkalization in the corresponding rhizosphere. In addition, the effect of the initial bulk-soil pH was the strongest for the poaceae, then the brassicaceae, and finally the solanaceae. These results consistently suggest that, in addition to the plant nutritional status, the initial bulk-soil pH and the specific metabolism of each plant species concomitantly drive pH changes in the rhizosphere.